Master's Thesis

The Assessment of Quality of Comprehensive Plan for Storm and Flood Damage Reduction in Korea

Junsung Park

Department of Urban and Environmental Engineering

(Disaster Management Engineering)

Graduate School of UNIST

2016

The Assessment of Quality of Comprehensive Plan for Storm and Flood Damage Reduction in Korea

Junsung Park

Department of Urban and Environmental Engineering
(Disaster Management Engineering)

Graduate School of UNIST

The Assessment of Quality of Comprehensive Plan for Storm and Flood Damage Reduction in Korea

A thesis
submitted to the Graduate School of UNIST
in partial fulfillment of the
requirements for the degree of
Master of Science

Junsung Park

1. 20. 2016
Approved by

_____

Advisor
Dong Keun Yoon

The Assessment of Quality of Comprehensive Plan for Storm and Flood Damage Reduction in Korea

Junsung Park

This certifies that the thesis/dissertation of
Junsung Park is approved.

1. 20. 2016

_____

Advisor: Dong Keun Yoon

_____

Gi-Hyoug Cho

_____

Jeongseob Kim

ABSTRACT

A comprehensive plan for storm and flood damage reduction (CPSFDR), required by Article 16 of Countermeasures against Natural Disasters Act, has a goal to reduce human and property damage and to make safety community. A CPSFDR is dealing with typhoon, flood, waves, tsunami, heavy snow and other natural disasters.

The purpose of this study is to develop the plan quality index to assess the quality of CPSFDRs in Korea. Total 75 elements were developed about fact basis, mitigation measures and plan implementation base on literature review, and three coders participated to assess plans. Content analysis was used to assess the quality of plans with 0-to-2 ordinal scale. 49 CPSFDRs were analyzed for this study among 158 municipalities. The result of assessment was compared interregional difference among assessment indices, and it was used to statistical analysis such as t-test and correlation analysis.

Through this study, four issues were found. First, CPSFDRs aim to structural mitigation measures mostly. Appropriate mixed using with structural measures and non-structural measures is important for effective disaster mitigation. Second, there is no regional difference between mitigation measures. There are similar mitigation measures in most municipalities, though there are various regional characteristics and ability to cope with natural disaster. Third, connectivity is deficient between CPSFDR and other disaster related plan such as an urban master plan and a river comprehensive plan. Especially, there are problem that overlap with hazard risk area and urban planned area. Fourth, there is no evaluation and monitoring plan in plan implementation section. Continuous evaluation and monitoring should be enforced before renewal, but detailed plans of them are not proposed in plans

Contents

LIST OF FIGURES
LIST OF TABLES

1. INTRODUCTION 1

2. LITERATURE REVIEW 2

2.1 Plan assessment and plan quality indicator 2

2.2 Plan quality assessment method 3

3. COMPREHENSIVE PLAN FOR STORM AND FLOOD DAMAGE REDUCTION (CPSFDR) 5

4. METHODS 7

4.1 Data 7

4.2 Plan quality index 9

4.3 Assessment 11

5. RESULTS 13

6. DISCUSSION 32

7. CONCLUSION 33

REFERENCE 35

APPENDIX 38

LIST OF FIGURES

Figure 1 Study area 8
Figure 2 Examples of CPSFDR about related organizations of disaster management 12
Figure 3 Spatial distribution of overall plan quality score 13
Figure 4 Plan quality scores of each principle 14
Figure 5 Plan quality scores of each indicator in fact basis 15
Figure 6 Plan quality scores of each detail indicator in vulnerability analysis 16
Figure 7 Plan quality scores of each detail indicator in capability analysis 17
Figure 8 Plan quality scores of each indicator in mitigation measures 19
Figure 9 Plan quality scores of each detail indicator in non-structural measures 20
Figure 10 Plan quality scores of each indicator in plan implementation 23
Figure 11 Overall plan quality and scores of principles of each province (Do) 24
Figure 12 Scores of indicators in fact basis of each province (Do) 25
Figure 13 Scores of indicators in mitigation measures of each province (Do) 26
Figure 14 Scores of indicators in plan implementation of each province (Do) 26

LIST OF TABLES

Table 1 Comparison of plan quality indices 2
Table 2 Comparison between assessment methods 4
Table 3 Required contents of CPSFDR by laws 6
Table 4 Sections and contents of CPSFDR (Gyeongsan) 7
Table 5 List of CPSFDRs 8
Table 6 Plan quality index 9
Table 7 Basic statistics of overall plan quality score 13
Table 8 Basic statistics of each principle 14
Table 9 Basic statistics of each indicator in fact basis 15
Table 10 Basic statistics of each detail indicator in vulnerability analysis 16
Table 11 Basic statistics of each detail indicator in capability analysis 18
Table 12 Basic statistics of each indicator in mitigation measures 19
Table 13 Basic statistics of each detail indicator in non-structural measures 21
Table 14 Basic statistics of each indicator in plan implementation 23
Table 15 The result of t-test with population density (principles and overall plan quality) 27
Table 16 The result of t-test with financial independence rate (principles and overall plan quality) 28
Table 17 The result of t-test with population density (indicators) 29
Table 18 The result of t-test with financial independence rate (indicators) 30
Table 19 The result of correlation analysis for overall plan quality and principles 31
Table 20 The result of correlation analysis for indicators 31

1. INTRODUCTION

Along with climate and environment change, occurrence trend of natural disaster is changing as frequency and scale of damage increase. To reduce disaster damage, various structural and non-structural measures are attempted. Among various measures, governments used mainly structural measures such as building dams or levees. However, there are many problems and limitations to aim only at structural measures like expense problem, thus, non-structural measures that are more effective and less cost were introduced (Phillips et al., 2011). Planning is one of the non-structural mitigation measures to reduce long-term risks and indirect effects from the hazard (Godschalk, 2003).

In Korea, annual economic damage from the natural disaster is 627 billion KRW in last 10 years (2005 – 2014). The government of Korea was introduced disaster-related comprehensive plan named comprehensive plan for storm and flood damage reduction (CPSFDR) to reduce disaster damages. A CPSFDR has a goal to reduce human and property damage and to make a safe community. It is required by Article 16 of Countermeasures against Natural Disasters Act in January 2005 on the typhoon, flood, waves, tsunami, heavy snow and other natural disasters.

Plan is the result of efforts in planning process, also it is to implement plan and to achieve goals in plan (Kang, 2012). If detail measures and clear goals are included in CPSFDRs, the plan can contribute for original purpose such as disaster damage reduction. It is important to assess quality of CPSFDR, because the result of assessment can be used to analyze present condition of CPSFDR establishment, and element data to judge improvement and supplement of plan.

The purpose of this study is to develop the plan quality index to assess the quality of CPSFDRs in Korea. Through assessment, the quality of established CPSFDRs are analyzed, and the improvements are proposed to supplement for effective disaster damage reduction. In addition, t-test was used to analyze the regional characteristics between each municipality, and correlation analysis were used to examine the effect of CPSFDR to reduce disaster damage. This study hypothesized that a municipality with higher financial resources has higher plan quality in plan of mitigation measures, and with a municipality with higher plan quality is better to mitigate disaster vulnerabilities and risks. For the analysis, three principles such as fact basis, mitigation measures, and plan implementation were employed. Total 75 elements were developed, and assessed the quality of each index.

2. LITERATURE REVIEW

2.1 Plan assessment and plan quality indicator

Plan qualities about various subjects were assessed on environmental plans, natural hazard, climate change, and coastal management. Many researchers used various assessment method to assess plan quality (Lyles & Stevens, 2014). To assess a plan quality is one of ways to measure policy leaning, because plan can indicate planning process and implementation (Brody 2003). Content analysis was used to assess the quality of hazard mitigation plans generally. There are some studies about to assess plan quality of comprehensive plan, also some studies about hazard mitigation that used plan quality assessment method (Berke et al., 2012).

Table 1 Comparison of plan quality indices

Article	Berke et al. (1996)	Brody (2003)	Srivastrava & Laurian (2006)
Contents	- Fact basis - Goals - Policies	- Factual base - Goals - Actions	- Factual basis - Goals and objectives - Mitigation strategies and policies
Article	Kang et al. (2010)	Horney et al. (2012)	Berke et al. (2012)
Contents	- Vision statement - Planning process - Fact basis - Mitigation goals & objectives - Inter-organization coordination & capabilities - Specific mitigation policies & actions - Implementation	- Goals - Fact base - Policies - Implementation and monitoring - Inter-organizational coordination - Participation	- Goals - Fact base - Mitigation policies - Implementation and monitoring - Inter-organizational coordination - Participation

Table 1 shows plan quality indices. Previous studies that assessed the plan quality about hazard mitigation identified three components as “a strong factual basis, clearly articulated goals, and appropriately directed policies” (Kaiser et al., 1995; Berke et al., 1996; Baer, 1997). Berke et al (1996) examined whether such state mandates make better local plans through plan quality assessment. For this study, 139 community plans in five states were used, and 3 components and 56 items were used in plan quality indicators. Brody (2003) compared the quality of hazard mitigation plans over an eight-year period. The study range is hazard mitigation plans of 60 local jurisdictions in Florida and

Washington in 1991 and 1999. 3 components such as factual base, goals and actions were used to assess the quality of hazard mitigation plan, and 63 items were included in that components. In the case of Srivastrava & Laurian (2006), the strengths and weaknesses of mitigation measures for various natural disaster were evaluated in local comprehensive plan. The study areas were 6 counties in Arizona. Similar indices with other researches such as factual base, goals, and mitigation strategies and policies were used to assess the plan quality, and 78 indicators were included in these components. Kang et al. (2010) examined the plan quality of 12 hazard mitigation plans of Coastal Management Zone of Texas. In this study, components were subdivided than previous researches such as vision statement, planning process, fact basis, mitigation goals, coordination, mitigation policies and action, and implementation. The plan assessment protocol that include 164 elements was developed for this study. Horney et al. (2012) compared the quality of hazard mitigation plans between 21 urban and 36 rural areas in southeastern states in the U.S. (Florida, Georgia, North Carolina). The plan quality indicator is composed 6 principles with 554 items. Berke et al. (2012) analyzed the past efforts to increase quality of the plan, and recommended to improve plan through the assessment. In this study, 6 principles of hazard mitigation plan were identified such as goal, fact base, policies (or actions), implementation and monitoring, inter-organizational coordination and participation based on Disaster Mitigation Act in the U.S, also 105 items were developed. In these articles, author subdivided the index than older researches before 2010 to add indices about coordination and plan implementation, because importance of coordination between organizations and plan implementation were emphasized in the role of plan.

2.2. Assessment method

Content analysis is used to assess plan quality, and there is a method to assess quantitatively in content analysis. It is used to compare between plan and to analyze statistically with other variables. Quantitative results of quality assessment are utilized to communicate easier among various stakeholders (Berke et al., 2006). Most research about plan quality used 0-2 scale to assess quantitatively except Srivastava & Laurian (2006). Especially, Berke et al. (2012) used both coding methods. In the case of 0-1 binary scale, each goal and policy was measured by each indicator, in which “0” is not mentioned, and “1” is mentioned. It called coverage score, because it represents that how many plans consider each indicator. In the case of 0-2 ordinal scale, each goal and policy was measured by each indicator, in which “0” is not mentioned, “1” is suggested but not detail, and “2” fully mentioned or required by the plan. It called depth score, because it represents that how contents are described in detail about each indicator (Kang et al, 2014).

Table 2 Comparison between assessment methods

Article	Index	Coding method	Score examination method
Berke et al. (2012)	6 principles 25 indices 105 items	0-1 scale & 0-2 scale	1) 0–1 scale was doubled to a 0–2 scale 2) Add the item score and take an average on all items in each component
Kang et al. (2010)	7 components 164 elements	0-2 scale	1) CQS (Component quality score): Sum of scores of all elements in each component converted into percentages based on the maximum score possible (Maximum = 100) 2) PQS (Plan quality score): The average of CQS
Srivastava & Laurian (2006)	3 components 78 indicators	0-1 scale	Average score for each component
Brody (2003)	3 components 63 items	0-2 scale	1) Sum the indicators within each of the plan components and divide the sum of the scores by the total possible score and convert to 10 scales 2) Overall plan quality is sum of all scores
Berke (1994)	3 principles 11 dimensions 56 items	0-2 scale	Average of the scores and convert to standardized scores from the lowest score of 0 and the highest score of 1 in each dimensions
Berke & Conroy (2000)	6 principles 27 elements	0-2 scale	1) Sum the scores assigned to policies under each principle within each element. 2) Standardize the indices by dividing the sum of scores by the maximum possible score and multiplying by 10
Evans-Cowley & Gough (2008)	3 categories	0-2 scale	1) The sum of the scores was assigned in each evaluation by category 2) Divide by the total number of points available to create a percentage score
Tang (2008)	5 components 63 indicators	0-2 scale	1) Sum the indicators within each of the plan components, and divide the sum of the scores by the total possible score and convert to 10 scales 2) Overall plan quality is sum of all scores

Most researchers took an average on elements in indicators or components. However, there are two measures to calculate overall plan quality such as average or sum of scores. Both measures are similar to assign same weights to each indicators, and they can be converted into 10 scale (Brody, 2003; Tang, 2008) or percentage score (Kang et al., 2010; Evans-Cowley & Gough, 2008) for easy analysis and comparison.

3. COMPREHENSIVE PLAN FOR STORM AND FLOOD DAMAGE REDUCTION (CPSFDR)

There are various plans about disaster management, damage reduction and mitigation in Korea. Plans as of disaster mitigation are managed by various laws. These laws are typically about urban planning and disaster management (Ok & Ryu, 2013). National Land Planning and Utilization Act, one of the urban planning, required to include disaster mitigation section in three levels of urban plan such as metropolitan city plan, urban master plan and urban management plan. In the case of Framework Act on the Management of Disasters and Safety, safety management plans are required by this law for each city and county. A comprehensive plan for storm and flood damage reduction (CPSFDR) is required by Countermeasures against Natural Disasters Act. CPSFDR's goal is to reduce human and property damage and to make safe community. It is required by Article 16 of Countermeasures against Natural Disasters Act in January 2005 in Korea dealing with typhoon, flood, waves, tsunami, heavy snow and other natural disasters. The guideline was made in 2007, and it was instructed to all municipalities in Korea in 2010. In January 2012, National Land Planning and Utilization Act was modified to make mandatory reflection of urban plan in establishment of CPSFDR. There is two level of CPSFDR as province (Do) level and city (Si, Gun, Gu) level. The plan of province level will be established based on plans of city level. 158 municipalities (cities and counties) in Korea have to establish this plan and, the target year of CPSFDR is 10 years from establishment to consider completion of mitigation measures implementation. Municipalities should be renewed after reexamination of plan validity, also they can change the plan when condition is changed by urban development and regeneration project for disaster risk zones. However, there is no the CPSFDR for level of the whole country, so the status of CPSFDR is relatively lower than other disaster-related plans (Kim et al., 2015).

CPSFDR is a comprehensive plan. The plan occupies broad goals that not only covers hazard mitigation content but also covers community and people. Contents of the plan consist direction and goal, analysis of current situation, analysis of disaster recovery, analysis of risk factors, designation of dangerous district, and comprehensive countermeasures. CPSFDR is the most significant plan in field of disaster prevention, so Enforcement Decree of the National Land Planning and Utilization Act regulated to reflect CPSFDR to establish or renew urban master plan. Article 13 of Enforcement Ordinance for Countermeasures against Natural Disasters Act mentioned rough contents of CPSFDR

with 8 sections, and the detail guideline required 4 sections with more detailed contents of plans (Table 3). In the 4 section of the detail guideline, all contents include the contents that are mentioned in Article 13 of Enforcement Ordinance for Countermeasures against Natural Disasters Act.

Table 3 Required contents of CPSFDR by laws

Law	Content
Article 13 of Enforcement Ordinance for Countermeasures against Natural Disasters Act	1) Regional characteristics and direction/goal of plan 2) Present condition of disaster occurrence and hazard risk factors such as present condition of basins, rivers, weather, and facilities for disaster prevention 3) Evaluation and analysis of disaster recovery project 4) Risk analysis of each region and facility 5) Mitigation measures that applied flood prevention standard in Article 18 6) Designation and maintenance of disaster risk district for disaster mitigation 7) Comprehensive measures for disaster prevention and mitigation 8) Contents that required by detail guideline of CPSFDR according to Article 14, Section 7
Detail guideline of CPSFDR	1) Investigation of basic present condition 2) Selection of disaster risk districts of each disaster type 3) Disaster mitigation measures 4) Implementation plan of mitigation measures

Table 4 represent the example of contents in CPSFDR of Gyeongsan. The plan is composed of six main sections and several detail contents in each main section. Other plans are composed also of similar contents, because all of plans were established based on the detail guideline of CPSFDR. Outline of plan establishment explain about purpose, scope, and process of plan establishment. In the section of present condition, various contents were explained through maps, tables, and graphs. In the section of disaster mitigation measures, mitigation measures were established in each level of region scale from whole region to disaster risk district. It was decided by the effect scale of each mitigation measures, so most non-structural measures were consisted in whole region. Implementation plan included the contents in investment priority and comprehensive map of whole mitigation measures. Expected effect and application is in last section of CPSFDR, and it included the contents in numerical analysis of expected effect and application measures.

Table 4 Sections and contents of CPSFDR (Gyeongsan)

Section	Detail content
Outline of plan establishment	- Background and purpose - Legal basis - Scope - Process
Present condition	- Direction - Data investigation (administration and natural disaster) - Result of survey
Selection of disaster risk district	- Standard of selection - Disaster risk district of each disaster type
Disaster mitigation measures	- Direction - Mitigation measures of whole region - Mitigation measures of each river basin - Mitigation measures of each disaster risk district - Connectivity and adjustment with other plans
Implementation plan	- Direction - Investment priority decision - Implementation plan by year and stage - Comprehensive map of CPSFDR
Expected effect and application measures	- Expected effect - Application measures - Improvement measures

4. METHODS

4.1 Data

As of March 2015, 95 CPSFDRs were approved, and 58 plans were in state of conditional approval, consideration, and reconsideration among 158 target municipalities (Joo et al., 2015). Total 49 municipalities' plans were used in this study, because only these plans were available to get from National Emergency Management Agency (Now: Ministry of Public Safety and Security). The spatial distribution of municipalities is represented on Figure 1, and the detail list of all plans in Table 5. The plans of gray colored regions were secured, and they were assessed by plan quality index. Study areas are distributed randomly because of data availability.

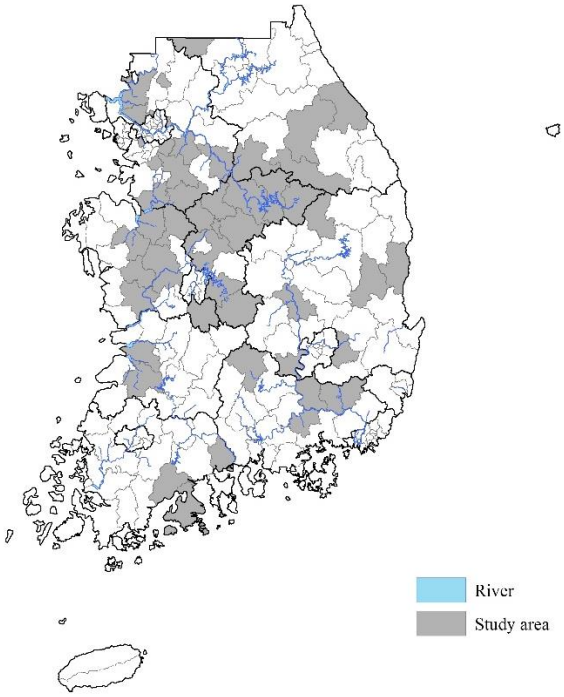

Figure 1 Study area

Table 5 List of CPSFDRs

Province	Municipality			Number of municipalities
Gyeonggi-do	Suwon Pyeongtaek Anseong Guri	Seongnam Gwangmyeong Yeoju Paju	Yongin Gwangju Goyang Dongducheon	12
Gangwon-do	Gangneung Cheolwon	Yeongwol Pyeongchang	Wonju	5
Gyeongsangbuk-do	Gyeongsan Yeongdeok	Goryeong Yeongju	Gumi Cheongsong	6
Gyeongsangnam-do	Geochang Haman	Miryang	Changnyeong	4
Jeollabuk-do	Gimje	Jeongeup		2
Jeollanam-do	Goheung	Gwangyang	Boseong	3
Chungcheongbuk-do	Chungju Yeongdong Eumseong Jincheon	Jecheon Jeungpyeong Danyang	Cheongwon Goesan Okcheon	10
Chungchoengnam-do	Gongju Asan Cheongyang	Geumsan Yesan	Buyeo Cheonan	7
Total				49

4.2 Plan quality index

Plan quality index that include 75 elements was developed to assess plan qualities to refer to literatures that assessed hazard mitigation plans and detail guideline of CPSFDR. It consists of three principles such as 'Fact basis', 'Mitigation measures' and 'Plan implementation'. Each principle has several indicators, and some indicators are divided into detail indicators to reflect various factors for assessment result. The detail guideline is built up of specific contents about present condition and plan implementation. Nonetheless, contents of mitigation measures were explained without detail examples. Therefore, indicators about 'Fact basis' and 'Plan mitigation' were developed to refer to the contents of detail guideline. In the case of 'Mitigation measures', contents of structural mitigation measures were developed to refer to contents of 49 CPSFDRs. However, contents of non-structural mitigation were developed to refer to related articles because of insufficient contents in CPSFDR about non-structural mitigation. Concrete list of indicators and number of elements are described in Table 6, and list of detail elements is attached in appendix.

Table 6 Plan quality index

Principle	Indicator		Number of elements
Fact basis	Hazard analysis		6
	Vulnerability analysis	Vulnerable population	3
		Vulnerable facility	4
		Vulnerable region	8
	Capability analysis	Manpower and organization	4
		Supplies and resources	2
		Facility	3
		Plan and education	3
Mitigation measures	Direction establishment		4
	Structural measures		11
	Non-structural measures	Regulation	4
		Incentive	4
		Education and training	3
		Information	4
Plan implementation	Investment priority and plan		4
	Evaluation and improvement		3
	Implementation and application		5
Total			75

Under the 'Fact basis' principle, there are three indicators such as 'Hazard analysis', 'Vulnerability analysis', and 'Capability analysis'. These indicators are assessed based on present condition of each municipality. In the 'Hazard analysis', there are some contents to analyze hazards in detail such as scale of damage, frequency, case study of disaster, and analysis of damage change by climate change. Total

6 elements are included in this indicator.

In the case of 'Vulnerability analysis', it consists of three detail indicator to cover vulnerable population, facility, and region. These indicators aim to assess vulnerability of each municipality. Total 15 elements are included in this indicator. In 'Vulnerable population', contents about vulnerable population are assessed with 3 elements: definition, present condition, and future estimation. In the case of 'Vulnerable facility', 4 elements are included in this indicator, and most of them are used to assess definition and analysis result of present condition of each facility type. Especially, cultural facilities such as relics are included. In 'Vulnerable region', there are 8 elements to assess qualities of contents about explanation of vulnerable region of each disaster type. In addition, a change of vulnerable area which is effected by urban development is one of plan quality indices in 'Vulnerable region'.

'Capability analysis' is the index to assess the capability of municipalities dealing with natural disaster. 'Manpower and organization', 'Supplies and resources', 'Facility', and 'Plan and education' are detail indicators of this indicator, and total 12 elements compose them. 'Manpower and organization' is used to assess capability through present condition of organizations and people in charge related in disaster management with 4 elements. In the case of 'Supplies and resources', the present condition of managing disaster related resources and relief goods is main assessment items. 'Facility' contains the elements about disaster related facilities such as disaster mitigation facilities and shelters. EAPs (Emergency Action Plan) established for facilities of damage prevention such as dams and reservoir are included also. Last indicator 'Plan and education' include elements about plans, education, and training. They are also used to assess contents of present condition about plans and educations. All of elements were selected to review all plans before assessment.

The second principle is 'Mitigation measures', and it is composed 3 indicators: 'Direction establishment', 'Structural measures', and 'Non Structural measures', and 30 elements. In the case of 'Direction establishment', there are 4 elements to assess which factors or how to consider in direction establishment process of mitigation measures such as regional characteristics, environment change, connectivity, resilience, and sustainability. Many researchers focused on the goal of plans, because it represents an aspiration of plan and needs of communities (Kang et al., 2010). To cover that, goal is included in plan quality index. Especially, many research used sustainability and resilience principles to assess the plan about hazard mitigation. Mileti and Peek-Gottsechlich (2001) defined sustainability as "a locality can tolerate and overcome damage, diminished productivity, and reduced quality of life from an extreme event without significant outside assistance". Mileti (1999) and Schneider (2002) argued that the conceptual linkage among hazard mitigation, sustainability and community planning. In the case of resilience, UNISDR (2005) defined resilience as "The capacity of a system, community or society potentially exposed to hazards to adapt, by resisting or changing in order to reach and maintain an acceptable level of functioning and structure". Some researchers used resilience as index to assess a

goal of hazard mitigation plans (Kang et al., 2010). Thus, these principles are included in plan quality index of 'Direction establishment'. In the case of 'Structural measures', the detail guideline of CPSFDR explained about the scale of mitigation measures only. As a result, there is no content to refer to plan quality index. However, all structural measures that mentioned in CPSFDRs are included, so the plan quality index was developed base on the contents of them and some literatures that explained structural mitigation measures (Godschalk & Brower, 1985; Phillips et al., 2011). It can be used to compare the plan quality to other plans easily, because all plans include theses contents. Most mitigation measures were about inundation prevention such as dam, levee, rainwater storage facility, and drainage lines. The number of indicators about another disaster such as slope disaster and wind hazard is relatively small because of its importance. These indicators covered maintenance and repair as well as new-construction. 'Non-structural measures' is similar to 'Structural measures', because the contents of that were explained roughly in the detail guideline. Therefore, all non-structural measures that mentioned in plans were used to develop plan quality index, and more measures were added to refer to literatures about disaster mitigation measures (Godschalk & Brower, 1985; Phillips et al., 2011). Since, contents of non-structural measures in local hazard plans are scantier than structural measures. Especially, this indicator is composed 4 detail indicators according to characteristics of measures as follow as regulatory measures such as land use regulation, incentive measures such as tax benefit, education and plan, and information such as forecasting and warning facility.

The third principle is 'Plan implementation', and it is composed 3 indicators: 'Investment priority and plan', 'Evaluation and improvement' and 'Implementation and application', and 12 elements. Measures to decide priorities of investment and results are included in 'Investment priority and plan'. In addition, financing measures that the important part to implement plans are also included in this indicator. 'Evaluation and improvement' includes contents to modify, renewal, and supplement. Along with and citizen participation is also considered because it is important factors to improve plans. Last indicator is 'Implementation and application'. In this indicator, there are 5 elements about how to utilize plan, and who or which organizations utilize plan. In detail, detail plan by year or stage, connectivity between nearby municipalities, and expected effect are included.

4.3 Assessment

The method of plan quality assessment developed by Berke et al. (1996) and Brody (2003) was employed to measure overall plan quality quantitatively. This method has each goal and policy was measured by each indicator on a 0- to 2-ordinal scale, in which "0" is not mentioned, "1" is suggested but not detailed, and "2" is fully mentioned or required by the plan. In this study, this assessment method was used to assess plan quality of CPSFDR.

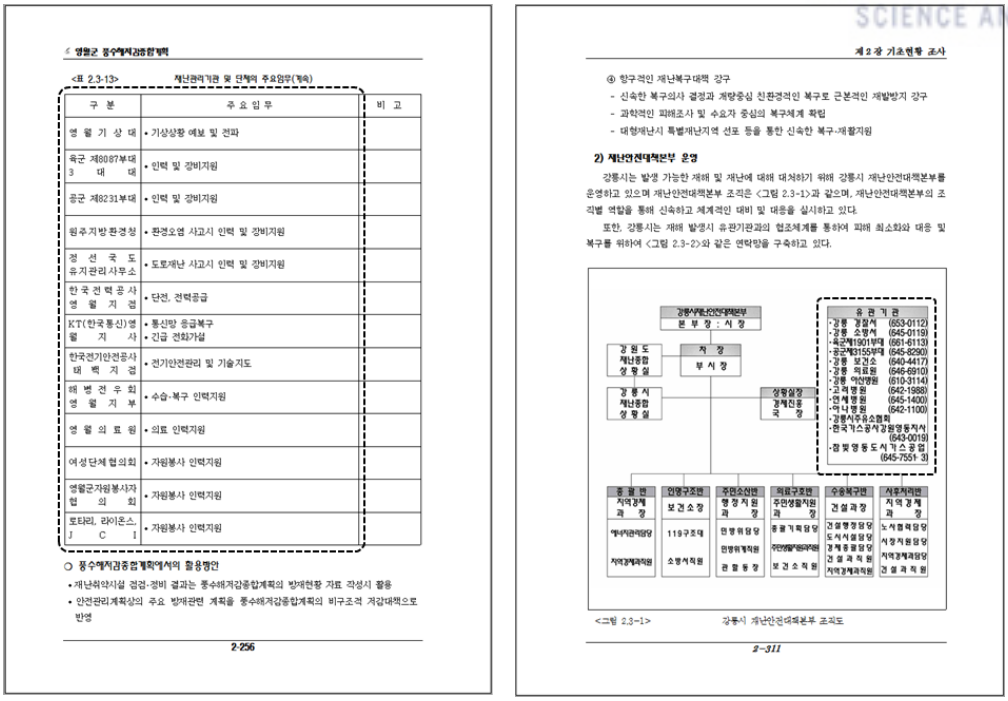

Figure 2 Examples of CPSFDR about related organizations of disaster management

(Left: Yeongwol, Right: Gangneung)

Figure 2 is the example of CPSFDR about related organizations of disaster management. Left one is the plan of Yeongwol, and right one is the plan of Gangneung. Plan of Yeongwol include list of disaster related organizations, and detail responsibilities of them. On the other hand, plan of Gangneung includes list of organizations only. In Yeongwol's case, the contents of related organizations were designated with detailed responsibilities, so it was scored '2'. However, the contents of Gangneung's plan were simple, so it was scored '1'.

Having assigned scores for each of the indicators, this study compared various measures to calculate overall plan quality and followed calculate measures that Brody (2003) used. First, the scores for each elements (E_i) were summed together within each of the indicator or detail indicator. Second, the summed scores were divided by the total score for each indicator ($2n_j$). Third, this fractional score was multiplied by 100 to convert a 0-to-100 scale from 0-to-2 scale. The final result is the indicator score (I_j).

$$I_j = \frac{100}{2n_j}\sum_{i=1}^{n_j} E_i$$

I_j is the plan quality for the jth indicator, and n_j is the number of elements within the jth indicator. Next step is to calculate a principle score by taking an average on indicator score of each principle. The

final step is to calculate a total plan quality score. It is also calculated by taking an average on the scores of each of three principles, and we used this score for the overall plan quality (Maximum score = 100). Also, it means that three principles have same weight.

In the study of Lyles et al. (2014), seven trained coders, including one of authors, were participated to evaluate plan. In this study, three coders participated in plan assessment to increase reliability of the quality of plan. All coders were educated with a sample plan and evaluated together, and discussed after assessment. Through discussion, scores were modified which contents were missed out during assessment, and established certain standard to assess details of each content.

5. RESULTS

Plan quality score

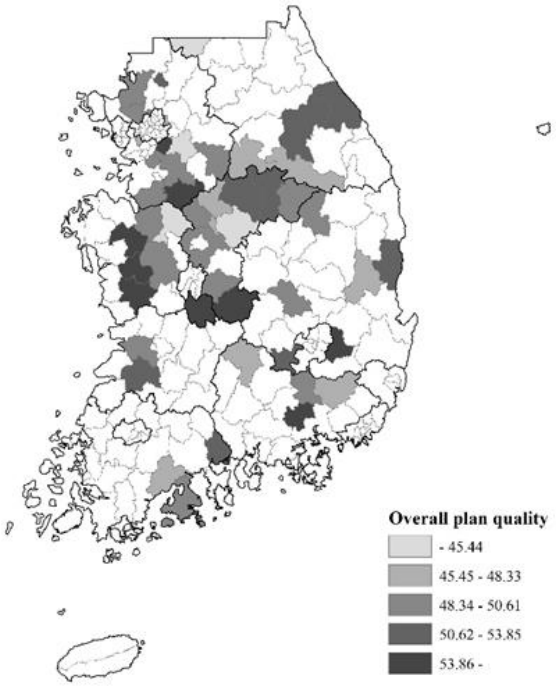

Figure 3 Spatial distribution of overall plan quality score

Table 7 Basic statistics of overall plan quality score

	Overall plan quality
Mean	50.41
S.D.	3.52
Min	41.56
Max	58.10

The spatial distribution and the range of overall plan quality scores are displayed on Figure 3. The range of overall plan quality is from 41.56 to 58.10, and the average score is 50.41. The municipality of the highest score is Haman (Score = 58.10) in Gyeongsangnam-do, and the municipality of the lowest score is Goesan (Score = 41.56) in Chungsheongbuk-do. Only 25 municipalities are over median of perfect score as 100.00, and the average score is near 50.00. The half score means that the plan includes all contents simply in plan quality indicators, but there is an insufficient part in the plan that plan quality score is under half score. Therefore, overall plan qualities of CPSFDRs are not high.

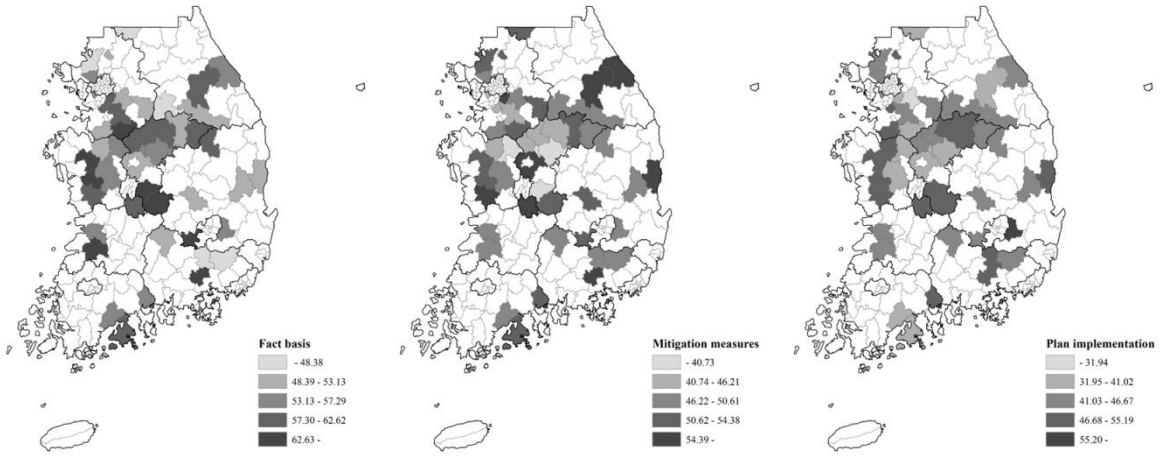

Figure 4 Plan quality scores of each principle

Table 8 Basic statistics of each principle

Principle	Mean	S.D.	Min	Max
Fact basis	56.33	6.59	38.04	70.49
Mitigation measures	49.56	5.80	28.60	63.04
Plan implementation	45.34	5.37	31.94	66.76

Plan quality indicators are divided into three principles: ‘Fact basis’, ‘Mitigation measures’, and ‘Plan implementation’. The spatial distribution of overall plan quality score is displayed on maps and graphs (Figure 4). In the case of ‘Fact basis’ principle, the range of score is from 43.75 to 73.77, and the average score is 56.33. Maximum, minimum, and average scores are highest among three principles. Most municipalities analyzed and described about regional present condition better than mitigation measures and plan implementation. Scores about detail indicators are described each principle and indicator with maps and graph also.

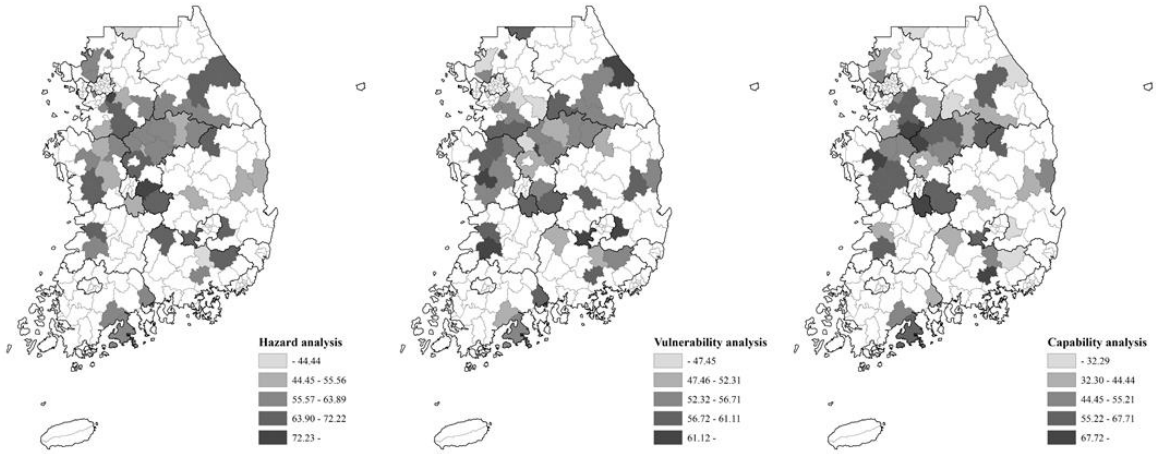

Figure 5 Plan quality scores of each indicator in fact basis

Table 9 Basic statistics of each indicator in fact basis

Indicator	Mean	S.D.	Min	Max
Hazard analysis	61.79	8.09	38.89	83.33
Vulnerability analysis	55.60	5.56	42.82	65.97
Capability analysis	51.59	15.85	16.67	81.94

There are three indicators in 'Fact basis'. In this principle, all contents are composed based on facts and present condition about hazard, vulnerability, and capability on disaster. First of them is 'Hazard analysis', and it is composed contents that identify and analyze natural hazards. The range of score is from 38.89 to 83.33, and the average is 61.79. The average score is over 50.00, so most plans considered and reflected the result of hazard analysis. Especially, damage scale, case of disaster, and cause of damage were described detail in the most plan. In the case of Seongnam (Score = 83.33), explanation of disaster situation that include precipitation, water level, and rate of discharge and regional disaster damage are described for each case of disaster. However, most plans didn't consider change of natural hazard trend by climate change, though past disaster damages are analyzed well. Climate change is mentioned only fragmentary sentences as "… Establishment of mitigation measures is necessary because of increase of precipitation intensity by abnormal climate and increase of impervious by urbanization …" in the plan of Anseong (Score = 72.22). The range of 'Vulnerability analysis' is from 42.82 to 65.97, and the average is 55.60. The range of 'Capability analysis' is from 81.94 to 16.67, and the average is 51.59. The difference between maximum and minimum score is largest in 'Capability analysis' as 65.27, and it means that the difference of plan qualities is larger than other indicators. Detail contents of both indicators are described with spatial distribution and range of score.

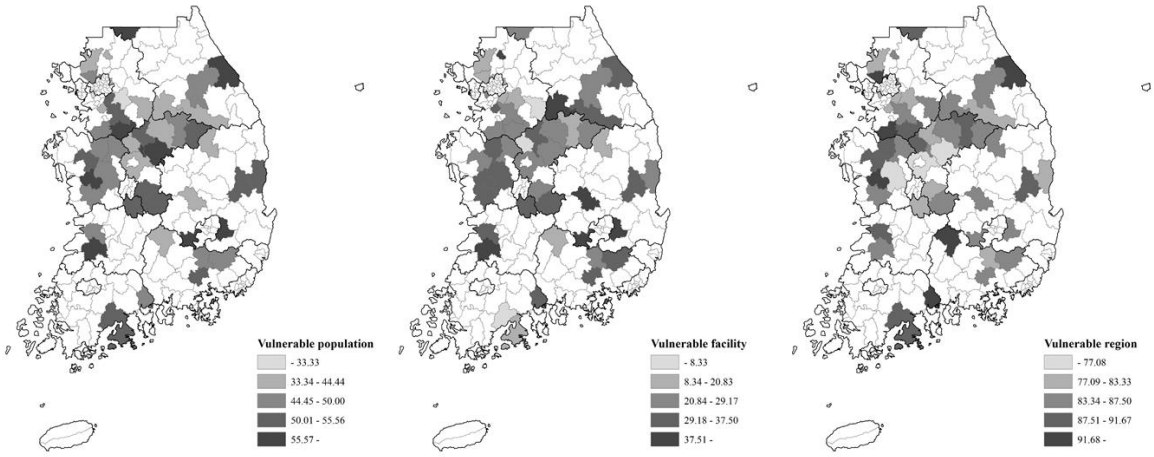

Figure 6 Plan quality scores of each detail indicator in vulnerability analysis

Table 10 Basic statistics of each detail indicator in vulnerability analysis

Detail indicator	Mean	S.D.	Min	Max
Vulnerable population	51.70	8.94	22.22	66.67
Vulnerable facility	28.57	10.03	4.17	45.83
Vulnerable region	86.52	5.16	72.92	95.83

There are three detail indicators in 'Vulnerability analysis' (Figure 6). The range of score of 'Vulnerable population' is from 22.22 to 66.67, and the average is 51.70. In this indicator, there are three elements as definition of vulnerable population, analysis of present condition, and analysis of change vulnerable population. Most plans have no content about estimation or analysis of the future vulnerable population. Plans which have some content about future vulnerable population even include simple content. For example, in the case of Gangneung (Score = 66.67), the plan mentioned future population to refer to urban master plan, but it has only overall population change. However, Jeongeup (Score = 66.67) estimated future population structure, and future elderly population who will be vulnerable to natural disaster was estimated by using that. The range of score of 'Vulnerable facility' is from 4.17 to 45.83, and the average is 28.57. The score of this indicator is lowest in 'Vulnerability analysis'. In this indicator, there are four elements about definition, critical facility, cultural facility, and hazardous facility. Most plans have detail contents about cultural facility such as location, present condition, and vulnerability. However, there is no content about definition of vulnerable facility, and a condition of hazardous facilities mostly. To analyze hazardous facilities is very important, because it has possibility to occur secondary damages from natural disaster such as fire, explosion, and chemical

discharge. All of municipalities didn't consider its importance to analyze. The range of score of 'Vulnerable region' is from 72.92 to 95.83, and average score is 86.52. The maximum and minimum score of this detail indicator are highest in the indicator of vulnerability analysis. Guideline of CPSFDR regulated to designate vulnerable zones of each natural disaster types such as river hazard, inundation, landslide and strong wind. Therefore, all municipalities designated vulnerable zones and detail contents of each zones include numerical and spatial analysis. Besides, coastal regions like Yeongdeok (Score = 81.25) included the content of vulnerable zones of coastal disaster such as tsunami and coastal erosion.

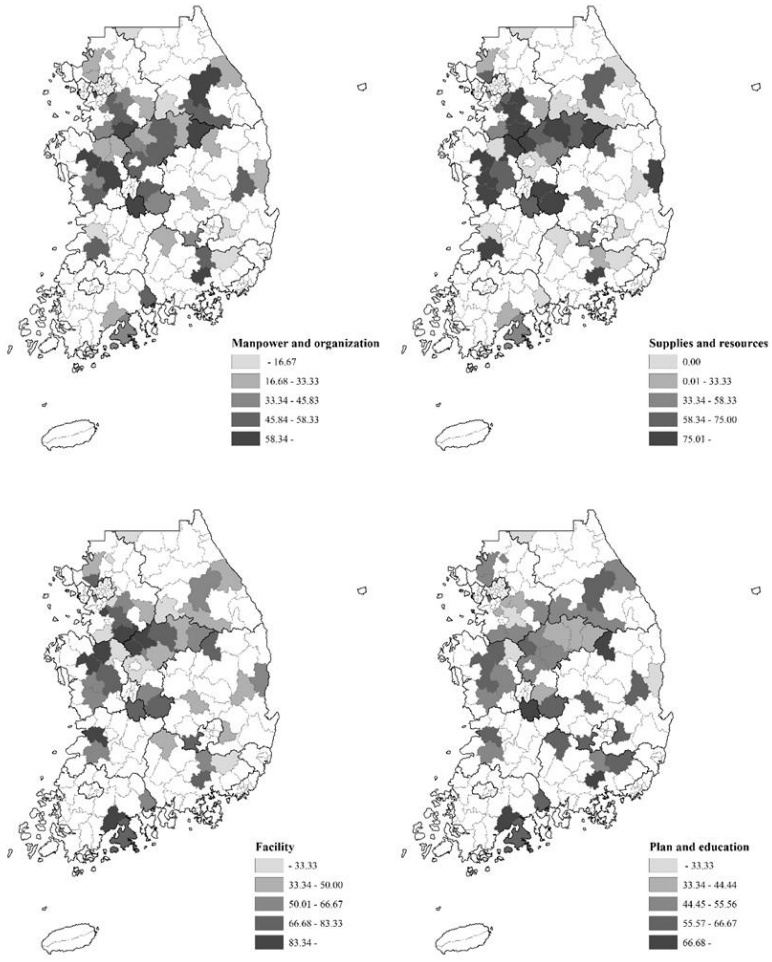

Figure 7 Plan quality scores of each detail indicator in capability analysis

Table 11 Basic statistics of each detail indicator in capability analysis

Detail indicator	Mean	S.D.	Min	Max
Manpower and organization	40.65	18.99	0.00	83.33
Supplies and resources	49.49	36.85	0.00	100.00
Facility	61.11	21.84	22.22	100.00
Plan and education	55.10	12.67	22.22	83.33

There are four detail indicators in 'Capability analysis' (Figure 7). The range of score of 'Manpower and organization' from 0.00 to 83.33, and the average score is 40.65. In this indicator, there are some elements about manpower and organization for disaster management such as government or voluntary organizations. Most plans include structures of disaster management organizations in each local government with organization charts, also it contains list and emergency contacts of related agencies such as police stations, fire stations, and military units. Some plans describe detailed duty and task of each organization or person. In the case of voluntary organizations appear rarely in plans, but it is described concretely in plans which mentioned them. In the case of Gongju (Score = 62.50), the plan includes the list of voluntary organizations, leaders, number of member, address, and major activities, but tasks on disaster state are insufficient. However, in the plan of Geumsan (Score = 66.67), the present condition and main task on disaster state of voluntary organizations are described focusing on local voluntary disaster prevention organizations. The range of score of 'Supplies and resources' from 0.00 to 100.00, and the average score is 49.49. It means that some plans didn't include the content about 'Supplies and resources'. There are two elements about disaster prevention equipment and relief goods. Most plans include the content to analyze present condition such as amount of equipment, storage sites, and detail kinds of goods. In the case of Anseong (Score = 100.00), the list of detailed disaster prevention items was described with standard for reserving goods, also the content about MOUs for supporting professional machinery is included such as reconstruction machinery because of problem to manage in local government. In addition, the plan described present condition of relief goods and manager in detail. Jeongeup include detail contents about all elements in 'Supplies and resources' indicator. In the 'Facility' indicator, there are three elements about disaster prevention facilities or shelters. The range of score of this indicator is from 22.22 to 100.00, and the average score is 61.11. Most plans include present condition of disaster prevention facilities with map, lists, and photos. All of facilities are categorized according to disaster type. In the case of elements about shelters, many plans include the content about that. For example, the present condition of victim camps is described in the plan of Gwangju (Score = 100.00) by regional levels such as the number of camps and capacities, but it is not detailed. In the case of Goyang (Score = 66.67), the present condition is described more detail than Gwangju, because it includes address, contacts, area, and staff in charge of each facility. However, scores of that element are same as 2 because of the limitation of assessment method. One of the elements

in this indicator is establishment of EAP (Emergency Action Plan) for reservoirs and dams, and the quality of the contents about EAP are various. Some plans just mentioned the necessity of EAP, but other plans summarized whole materials in each EAP. Asan (Score = 100.00) inclued detail contents about all elements in 'Facility' indicator. The fourth indicator is 'Plan and education', and it contains three elements about disaster related plans and educations. The range of score is from 22.22 to 83.33, and the average score is 55.10. All of plans include related plans that were established earlier such as land use plan, urban master plan, and safety management plan. Connectivity parts and plans for introduction to CPSFDR are described also each related plan. However, most plans have no disaster related education or training or contain very fragmentary contents. For example, the content of regular training program is described in the plan of Haman (Score = 77.78), also other plans mentioned about education and training that are included in related plans. All dispersions of scores are large to compare with other detail indicators.

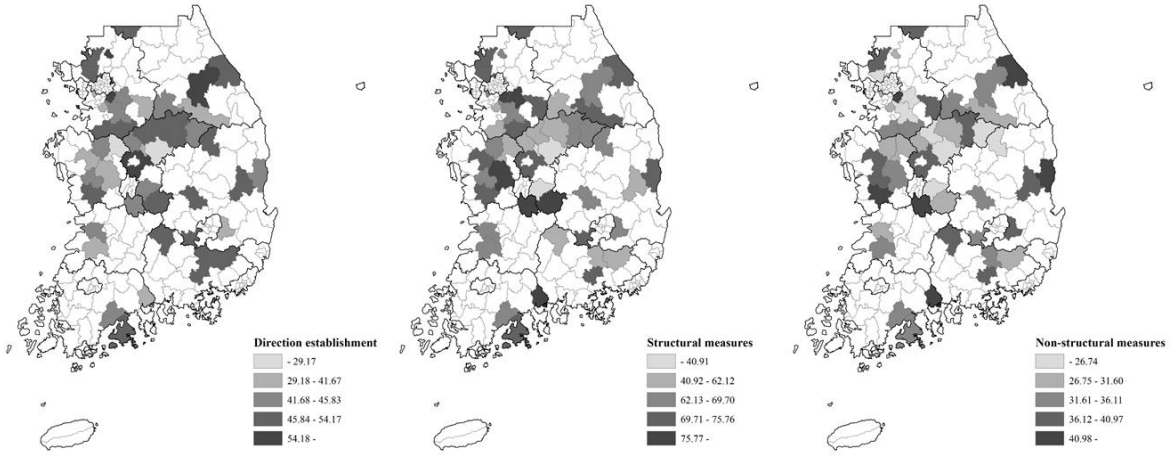

Figure 8 Plan quality scores of each indicator in mitigation measures

Table 12 Basic statistics of each indicator in mitigation measures

Indicator	Mean	S.D.	Min	Max
Direction establishment	48.04	7.71	25.00	66.67
Structural measures	66.70	10.13	37.88	83.33
Non-structural measures	33.93	6.63	21.18	46.53

'Mitigation measures' is composed three indicators such as 'Direction establishment', 'Structural measures', and 'Non-structural measures', and spatial distribution of scores are represented by map (Figure 8). The range of 'Direction establishment' score is from 25.00 to 66.67, and the average score is 48.04. In this indicator, there are some elements that are related various factors of direction

establishment such as regional characteristics, environment change, connectivity, sustainability, and resilience. The plan of Pyeongchang (Score = 66.67) that have the highest score in this indicator include all elements. Especially, this plan described regional characteristics of each natural disaster type with table. In contrast, concepts of sustainability and resilience are not included in most plans. Some plans that include that concepts mentioned only simple sentences. The score of 'Structural measures' is highest among three indicators, and the average score (66.70) is over 50.00. The content about structural measures were well to compare with other indicators. In this indicator, there are some elements to assess plan quality of various structural mitigation measures. For example, the case of dam construction, most municipalities have dams or plans to construct, so most contents are summary of present condition or existing construction plan. Other contents of structural measures are described also with maps and blueprints. The plan of Geumsan (Score = 83.33), that scored highest, include contents of most elements except elevation of ground level. In contrast, the score of non-structural measures is lowest among three indicators. Besides, the maximum score (46.53) is under half of full score, so the plan quality of 'Non-structural measures' is relatively lower than structural measures. Scores of detail indicators in 'Non-structural measures' are represented by maps and graphs (Figure 8).

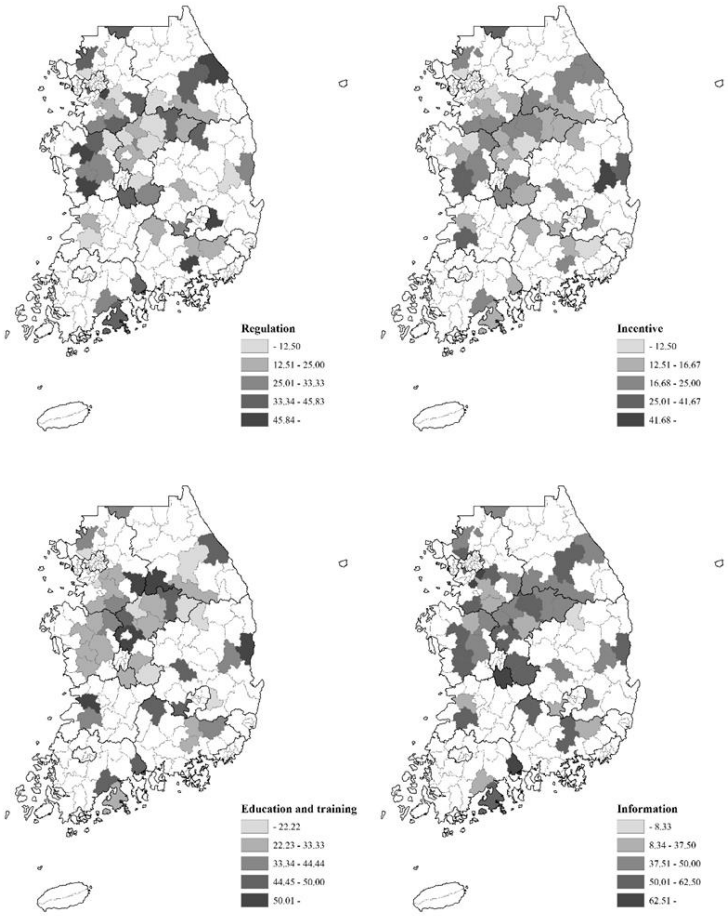

Figure 9 Plan quality scores of each detail indicator in non-structural measures

Table 13 Basic statistics of each detail indicator in non-structural measures

Detail indicator	Mean	S.D.	Min	Max
Regulation	29.59	15.64	4.17	66.67
Incentive	20.58	8.35	8.33	54.17
Education and training	35.71	12.98	11.11	61.11
Information	49.83	13.06	8.33	79.17

There are 4 detail indicators and 15 elements in 'Non-structural measures'. In the 'Regulation', there are elements to assess regulatory measures such as land use regulation and building code. The range of score is from 4.17 (Goyang) to 66.67 (Gyoengsan), and the average score is 29.59. Scores of 87.8% (43 municipalities) of 49 municipalities are under 50.00. Most plans mentioned the establishment of regulation about strong wind and new building standard about that. However, most contents about land use regulation are mentioned with simple sentences. For example, the plan of Gyeongsan mentioned as "It is necessary to regulate development underground space and critical facility on lowland of riverside with land use regulation, also it is important to set up elevation of site over design-flood-level", though it scored highest among municipalities. In case of building code, most plans described about standard wind speed for design to prevent damage of vinyl greenhouses and signboards. Several plans mentioned to regulating pilotis to buildings in flood vulnerable area additionally. However, contents about evacuation criteria and conservation of nature are not included in most plans.

The second detail indicator is 'Incentive', and there are 4 elements about incentive measures that are contrary to regulatory measures in 'Regulation' indicator. The range of scores is from 8.33 (Seongnam and Goyang) to 54.17 (Cheongsong), and the average score is 20.58. The overall quality of this indicator is lowest between detail indicators in 'Non-structural measures', and it means insufficiency because of lower score than 50.00, and it is lower than 'Regulation'. In this indicator, main contents of elements are tax benefit, storm and flood insurance, and enhancement of volunteers. Most plans include the content to enhance and expand contract of storm and flood insurance, but measures are very similar. In the case of Cheongsong, the plan described measures of enhancement storm and flood insurance as enhancement of publicity activities and incentive by comparison of insured rate, also other plans mentioned similar measures. Especially, detailed scale of financial supporting and the goal rate are described in the plan of Cheongsong. However, contents about tax benefit, and enhancement of volunteers are not included in most plans, though most plans include measures to expand storm and flood insurance.

The third detail indicator is 'Education and training', and it contains 3 elements to assess the plan quality of disaster related education and training such as training program about EAP and education program for ordinary people or experts. The range of scores is from 11.11 (Danyang, Pyeongchang, and

Gwangmyeong) to 61.11 (Wonju), and the average score is 35.71. The score is also very low alike other detail indicator in 'Non-structural measures', and only 5 municipalities are over 50.00. In the case of EAP, most plans that include the content about EAP contain training plans for evacuation. In contrast, contents about education and training are mentioned simply or not. For example, education measures are described as "Production and supply of disaster education and publicity materials that reflect regional characteristics, consideration for regular education, and education measures for people in charge of disaster prevention are proposed." in the plan of Wonju. However, there are no concrete measures about mentioned contents like detail contents of education program and education material.

Last detail indicator is 'Information', and it contains 4 elements about disaster information acquisition, display, and transmission measures. The range of scores is from 8.33 (Yeongju) to 79.17 (Seongnam and Geumsan), so the range is widest in 'Non-structural measures'. The average score is highest as 48.83. In detail, contents of hazard map, communication system, and forecasting and warning system are included. There is no plan that contain measures to construct emergency communication system. Most plans described the plan to make hazard maps and to reinforce forecasting and warning system. Most contents about hazard map are selection of risk regions that need to make hazard maps, and the process of making. Besides, some plans include example of hazard maps that are made in advance. In the case of forecasting and warning system, most plans analyzed present condition of forecasting and warning facilities, and necessity of supplementation or reinforcement. For example, information of existing forecasting and warning facilities such as rain gauges, hydrographs, and CCTVs are analyzed spatially with maps, and detail measures are suggested such as data sharing network between disaster related organizations, and data capturing system on real time in the plan of Seongnam. The plan of risk sign installation is converged on steep slope-land risk district except the plan of Yeongdeok (Score = 58.33). Yeongdeok mentioned the plan of installation on coastal hazard risk district because of regional characteristics.

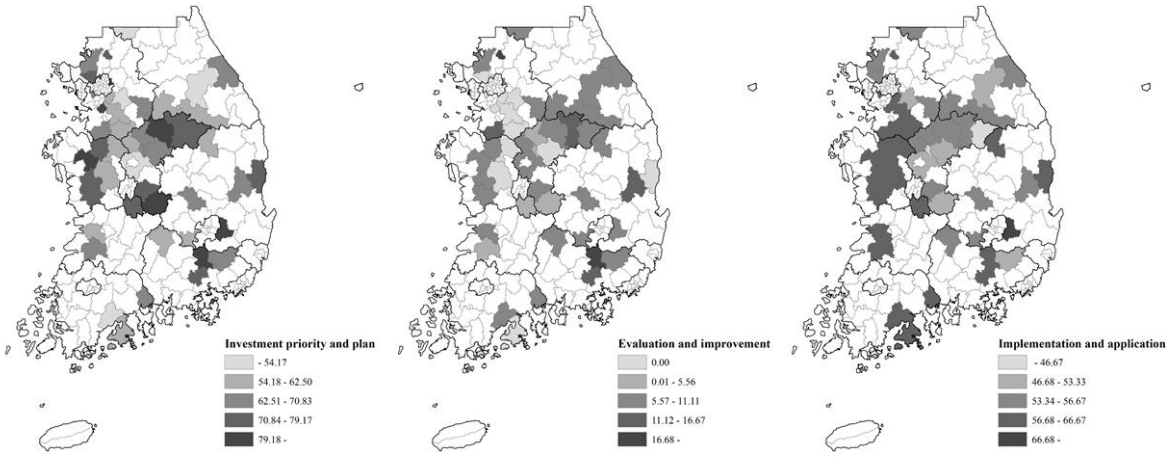

Figure 10 Plan quality scores of each indicator in plan implementation

Table 14 Basic statistics of each indicator in plan implementation

	Mean	S.D.	Min	Max
Investment priority and plan	69.05	10.49	45.83	95.83
Evaluation and improvement	8.73	6.00	0.00	22.22
Implementation and application	58.23	6.53	43.33	93.33

In the 'Plan implementation', there are 3 detail indicators and 12 elements. The first indicator is 'Investment priority and plan', and this indicator is used to assess plan qualities about measures to select priority and plans of investments for various disaster mitigation measures. The range of scores is from 45.83 (Gwangju) to 95.83 (Gyeongsan), and the average score is 69.05. These scores are higher than other indicators, also the average score is over 50.00. The determination process of investment priority is adduced on the guideline, so most plans refer to that to make this part. In addition, civil complaint, discussion with related organizations, and regulation result with related plans were reflected to decide priority. These were converted to evaluation items, and evaluated to quantitative ranking. For example, the plan of Gyeongsan divided evaluation items to basic items with 6 detail items and additional items with 3 detail items, and it describes the detail process and measures to decide priority. Results of determination are also arranged well with scores of detail items. In the case of connectivity, it was assessed at one of evaluation items as status of related plans. Most plans evaluated status of related plans with binary scale as 0 and 1, but some plans which have higher scores evaluated with ordinal scale from 0 to 2 to consider the circumstantiality of plan.

The second indicator is 'Evaluation and improvement', and it is the indicator to assess contents for

plan evaluation and improvement to make better plan. The range of scores is from 0.00 to 22.22 (Dongducheon and Changnyeong), and the average score is 8.73. The average score is lowest in this principle. This indicator consists of 3 elements such as evaluation and monitoring, modification and supplementation, and measures of citizen participation for plan improvement. Countermeasures against Natural Disasters Act regulated that have to renew every 5 years, so most plans mentioned it simply. In addition, necessary of frequent adjustment is mentioned also rather than to postpone renewal period every 5 years. However, all contents of renewal mentioned only simple sentences, and plan evaluation, monitoring, and citizen participation were not included.

The third indicator is 'Implementation and application', and it contains 5 elements about detail measures to implement or use. The range of scores is from 43.33 (Danyang) to 93.33 (Gyeongsan), and the average score is 58.23. All plans have implementation and investment plans by year, also expected effects of each measure are described with numerical analysis. For example, in the case of Gyeongsan, the expected effect of mitigation measures in Geumho-river is described such as solving the flood risk, shorten inundation period, and protection 169.06 ha and 150 buildings. Some natural disasters occurred locally, but most of them can influence to wide area. Thus, the connectivity between nearby regions is very important to implement CPSFDR. However, contents about that are not included in most plans except the plan of Cheonan. The content is included that necessary of a close cooperation of municipalities when a river is divided jurisdictions of several municipalities in the plan of Cheonan. In the case of plan application, there are detail contents about how to use a CPSFDR to establish other related plan in most plans, but there is no content or very simple content about application measures of who or which organizations. Only lists of related organizations are described, and there are no detail application measures.

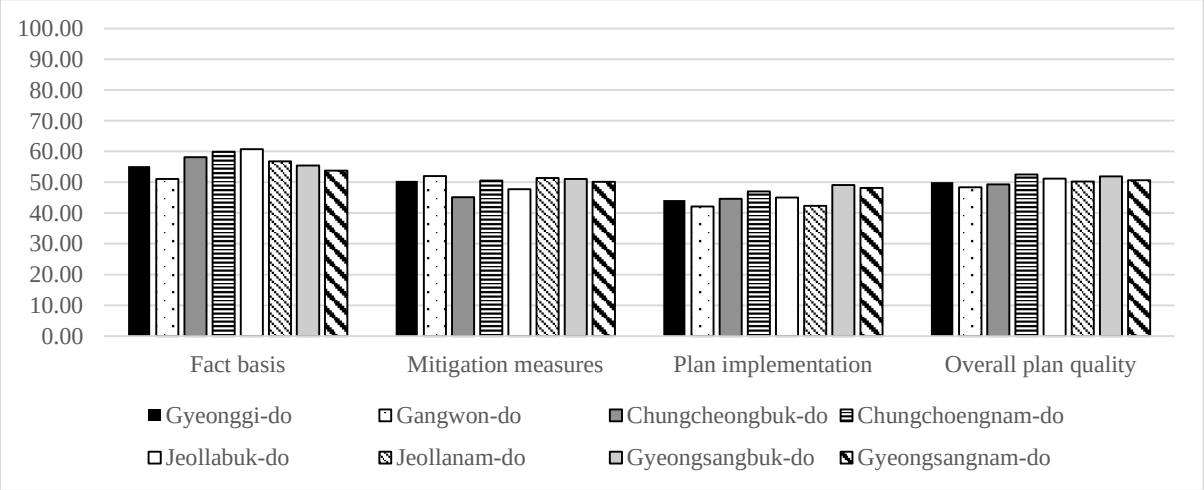

Figure 11 Overall plan quality and scores of principles of each province (Do)

To compare the difference of plan qualities between provinces (Do), the scores of each principles and overall plan quality were taken an average on municipalities in each province. Figure 11 shows the result of them. All provinces have similar overall plan quality near 50.00. Chungcheongbuk-do scored the highest overall plan quality as 52.51, but Gangwon-do scored the lowest score as 48.42. However, there is no large difference, so it is hard to compare plan quality using overall plan quality only. In the cases of principles, there are differences in each principle. The highest score in fact basis was scored in Jeollabuk-do as 60.76, and the lowest score was scored in Gangwon-do as 51.11. The scores of fact basis are highest in most provinces among principles except Gangwon-do.

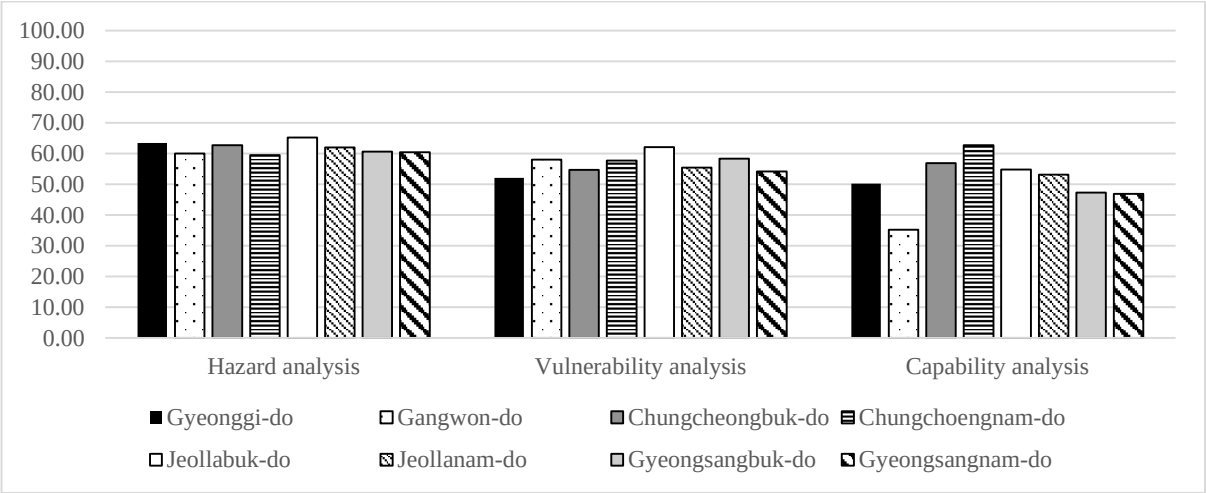

Figure 12 Scores of indicators in fact basis of each province (Do)

In the case of fact basis, there is evident difference in capacity analysis, but all provinces have similar scores in hazard analysis and vulnerability analysis. Gangwon-do scored the lowest plan quality in capacity analysis as 35.28, and it means that plans are deficient the contents about capability of municipalities dealing with natural disaster in Gangwon-do. In comparison, Chungcheongnam-do scored highest plan quality in capacity analysis, and other scores are over the average value. Municipalities in Chungcheongnam-do established relatively higher quality plan about fact basis.

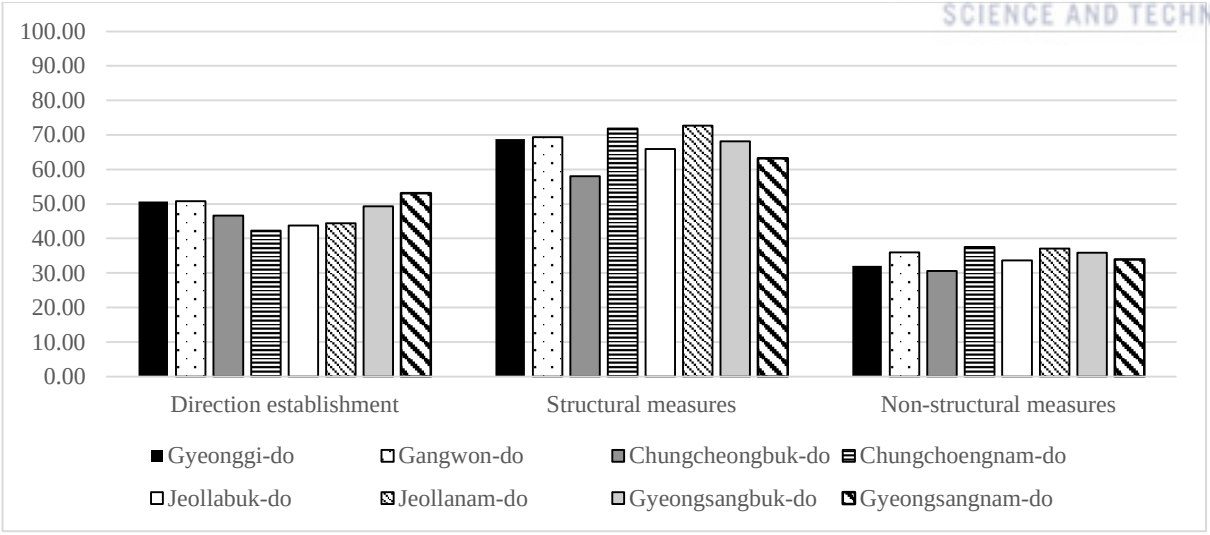

Figure 13 Scores of indicators in mitigation measures of each province (Do)

Among indicators in mitigation measures, scores of structural measures are highest in all province, and non-structural measures scored the lowest plan quality in common. It means that all provinces aimed to structural measures than nonstructural measures to reduce disaster damages. There is no unusual difference in direction establish and non-structural measures, but Chuncheongbuk-do have relatively lower quality in structural measures. Municipalities in Chuncheongbuk-do established plan about structural measures, but the contents are explained simply.

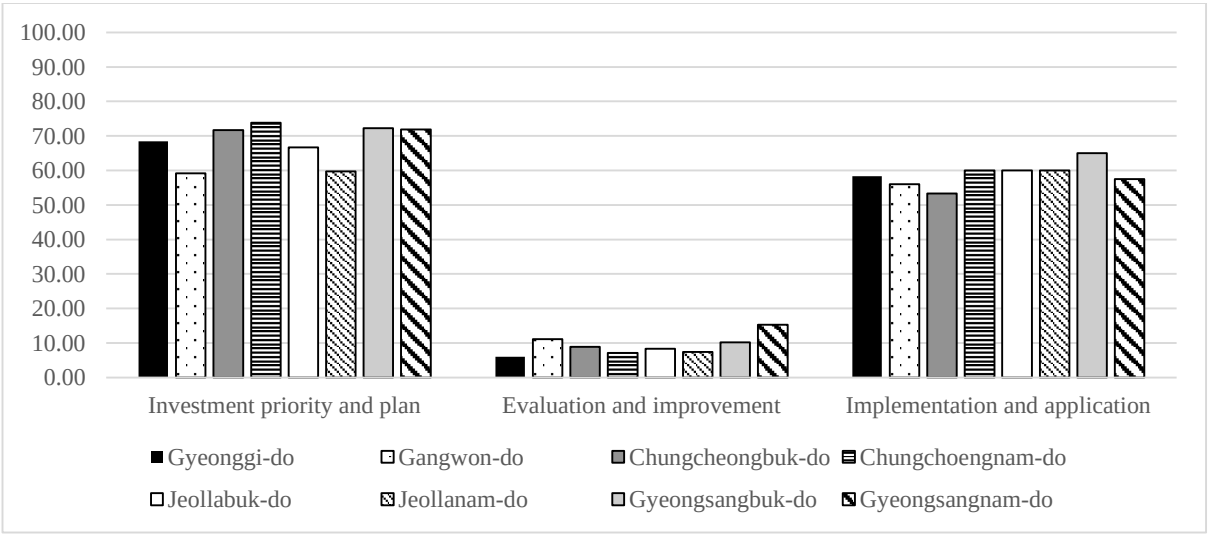

Figure 14 Scores of indicators in plan implementation of each province (Do)

In plan implementation, most indicators scored higher plan quality than 50.00 except the indicator about evaluation and improvement. All provinces have very low scores near 10.00, and it means that all municipalities have very simple plans or don't have plans about evaluation and improvement. There is no evident difference except investment priority and plan. Gangwon-do and Jeollanam-do have relatively lower scores than others, but they have contents about all elements.

There are some problems to compare plan quality between provinces because of sample limitations. The numbers of samples are different in each province, and it is not collected perfectly because of data accessibility. For example, there are most plans in Gyeonggi-do as 12 municipalities, but only two municipalities were collected in Jeollabuk-do.

T-test

Plan quality of CPSFDR is different from each municipality, so independent samples t-test was used to analyze the difference of plan quality scores by regional characteristics. For t-test, population density and financial independence rate were used in factors. The population density was used for the factor to discern urban and rural area. The criterion of population density is 485.6 people/km^2, because this value is average of Korea. Financial independence is the rate for independent revenue of total revenue of municipalities, so it was used to the index of economic power. The criterion of financial independence is 45.1%, because this value is average rate of all municipalities in Korea.

Table 15 is the result of t-test with population density, and compared average plan quality scores of principles and overall score. There is very small difference in all principles. The averages of urban area (> 485.6) are bigger than rural area (< 485.6) except plan implementation. In the case of overall plan quality, rural area is bigger than urban area. However, there is no principle which is statistically significant.

Table 15 The result of t-test with population density (principles and overall plan quality)

Principle	Population density (over 485.6)		Population density (under 485.6)		t	P
	Mean	S.D.	Mean	S.D.		
Fact basis	54.511	4.904	56.981	7.049	-1.162	0.251
Mitigation measures	48.760	5.529	49.845	5.939	-0.574	0.569
Plan implementation	46.282	8.256	44.995	3.971	0.540	0.598
Overall plan quality	49.851	3.315	50.607	3.612	-0.660	0.512

***: p<0.01, **: p<0.05, *: p<0.1

Table 16 is the result of t-test with financial independence rate, and compared average plan quality scores of principles and overall score. The average score of region which financial independence rate

is over 45.1% is bigger than others except plan implementation and overall plan quality. The difference of average scores in plan implementation is statistically significant. In the case of mitigation measures, municipalities that have lower financial independence established higher quality plan about incentive, and education and training in non-structural mitigation.

Table 16 The result of t-test with financial independence rate (principles and overall plan quality)

Principle	Financial independence rate (over 45.1%)		Financial independence rate (under 45.1%)		t	P
	Mean	S.D.	Mean	S.D.		
Fact basis	59.066	4.458	56.082	6.731	0.865	0.391
Mitigation measures	50.318	9.219	49.489	5.549	0.272	0.787
Plan implementation	40.903	7.195	45.732	5.100	-1.759*	0.085
Overall plan quality	50.096	3.931	50.434	3.526	-0.182	0.856

***: p<0.01, **: p<0.05, *: p<0.1

Table 17 and 18 are the result of t-test with indicators to analysis the difference of indicators' scores in each index such as population density and financial independence rate. In the case of result of population density (Table 17), only the average scores of 4 indicators have statistically significant difference such as vulnerable population, incentive, education and training, and implementation and application. Except implementation and application, average plan quality scores are bigger in municipalities under average population density. The regions that have lower population density investigated present condition about vulnerable people more detailed, and they established higher quality plans about non-structural measures. However, the contents of implementation and application are more simple.

In the case of result of financial independence rate (Table 18), the average scores of 5 indicators have statistically significant such difference as supplies and resources, plan and education, incentive, education and training, and evaluation and improvement. Except supplies and resources in capacity analysis, municipalities under 45.1% financial independence rate have higher average scores. The municipalities that have higher financial independence investigated and wrote the contents about supplies and resources of disaster management, but the contents about plan and education are deficient. In the case of mitigation measures, municipalities that have lower financial independence established higher quality plan about incentive, and education and training in non-structural mitigation. Non-structural mitigation measures need lower money than structural measures, so municipalities of lower financial independence concentrate on establish the plan about non-structural mitigation. In addition, municipalities of lower financial independence have higher quality of the plan for evaluation and improvement.

Table 17 The result of t-test with population density (indicators)

Indicator			Population density (over 485.6)		Population density (under 485.6)		t	P
			Mean	S.D.	Mean	S.D.		
Fact basis	Hazard analysis		61.752	8.940	61.806	7.895	-0.020	0.984
	Vulnerable analysis	Vulnerable population	47.009	10.786	53.395	7.661	-2.304**	0.026
		Vulnerable facility	29.487	10.130	28.241	10.114	0.381	0.705
		Vulnerable region	86.699	4.381	86.458	5.467	0.143	0.887
	Capacity analysis	Manpower and organization	34.615	14.964	42.824	19.985	-1.347	0.184
		Supplies and resources	49.359	37.801	49.537	37.051	-0.015	0.988
		Facility	54.701	24.517	63.426	20.675	-1.241	0.221
		Plan and education	50.855	11.751	56.636	12.795	-1.425	0.161
Mitigation measures	Direction establishment		48.397	9.553	47.917	7.078	0.191	0.849
	Structural measures		66.900	8.478	66.625	10.778	0.083	0.934
	Non-structural measures	Regulation	27.244	19.141	30.440	14.393	-0.627	0.533
		Incentive	16.346	5.759	22.107	8.673	-2.217**	0.032
		Education and training	29.060	10.432	38.117	13.090	-2.246**	0.029
		Information	51.282	12.544	49.306	13.382	0.464	0.645
Plan implementation	Investment priority and plan		71.154	13.336	68.287	9.358	0.842	0.404
	Evaluation and improvement		6.410	7.806	9.568	5.076	-1.358	0.193
	Implementation and application		61.282	10.412	57.130	4.075	2.028**	0.048

***: p<0.01, **: p<0.05, *: p<0.1

Table 18 The result of t-test with financial independence rate (indicators)

Indicator			Financial independence rate (over 45.1%)		Financial independence rate (under 45.1%)		t	P
			Mean	S.D.	Mean	S.D.		
Fact basis	Hazard analysis		67.361	12.704	61.296	7.570	1.454	0.153
	Vulnerable analysis	Vulnerable population	47.222	10.638	52.099	8.807	-1.046	0.301
		Vulnerable facility	23.958	9.845	28.981	10.049	-0.959	0.342
		Vulnerable region	83.854	2.621	86.759	5.277	-1.081	0.285
	Capacity analysis	Manpower and organization	43.750	7.217	40.370	19.721	0.338	0.737
		Supplies and resources	83.333	15.215	46.481	36.777	3.930***	0.006
		Facility	65.278	25.408	60.741	21.789	0.395	0.695
		Plan and education	40.278	8.333	56.420	12.192	-2.582**	0.013
Mitigation measures	Direction establishment		48.958	9.239	47.963	7.674	0.245	0.807
	Structural measures		70.833	13.346	66.330	9.909	0.849	0.400
	Non-structural measures	Regulation	25.000	22.567	30.000	15.169	-0.609	0.546
		Incentive	13.542	3.989	21.204	8.372	-1.799*	0.078
		Education and training	27.778	4.536	36.420	13.272	-2.871**	0.019
		Information	58.333	19.543	49.074	12.370	1.371	0.177
Plan implementation	Investment priority and plan		63.542	17.472	69.537	9.805	-1.098	0.278
	Evaluation and improvement		0.000	0.000	9.506	5.634	-11.320***	0.000
	Implementation and application		59.167	6.872	58.148	6.573	0.296	0.768

***: p<0.01, **: p<0.05, *: p<0.1

Correlation analysis

Correlation analysis was used to examine the effect of CPSFDR to reduce disaster damage. Disaster property damages from 2012 to 2014 were used for correlation analysis, because most plans were established around 2012. Disaster property damages were converted to logged values because of normal distribution. First, overall plan quality and scores of each principle were used to analyze generally. Second, scores of indicators and detail indicators in each principle were used also to analyze in detail.

Table 19 The result of correlation analysis for overall plan quality and principles

	Fact basis	Mitigation measures	Plan implementation	Overall plan quality
Disaster property damage	-0.120	0.026	-0.417**	-0.273*

***: p<0.01, **: p<0.05, *: p<0.1

Table 19 presents the result of correlation analysis for overall plan quality and principles. The result indicated that overall plan quality has negative relationship with disaster property damage and it is statistically significant. The municipality that has higher plan quality was damaged less than other municipalities, and it showed the quality of CPSFDR have the effect to reduce disaster damage. In cases of principles, fact basis and plan implementation have negative relationship, and mitigation measures have weak positive relationship with disaster property damage. However, only plan implementation is statistically significant. It showed that the good implementation plan can reduce disaster damages or lower damaged municipalities have high quality implementation plans.

Table 20 The result of correlation analysis for indicators

Fact basis								
	Hazard analysis	Vulnerability analysis			Capability analysis			
		Vulnerable population	Vulnerable facility	Vulnerable region	Manpower and organization	Supplies and resources	Facility	Plan and education
Disaster property damage	-0.087	-0.209	-0.144	0.106	-0.003	-0.026	-0.077	-0.023

Mitigation measures						
	Direction establishment	Structural measures	Non-structural measures			
			Regulation	Incentive	Education and training	Information
Disaster property damage	-0.078	0.067	-0.056	0.066	0.035	0.104

Plan implementation			
	Investment priority and plan	Evaluation and improvement	Implementation and application
Disaster property damage	-0.368***	-0.038	-0.402***

***: p<0.01, **: p<0.05, *: p<0.1

Table 20 presents the result of correlation analysis for indicators and detail indicators in each principle. In the case of fact basis, most indicators have negative relationship with disaster property damage except vulnerable region, but all of indicators are not statistically significant. In the case of mitigation measures, most indicators have positive relationship except direction establishment and regulation in non-structural measures, but there is no coefficient that is statistically significant. All of indicators in plan implementation have negative relationship with disaster property damages, and two indicators are statistically significant except evaluation and improvement. These results could show that municipalities with high quality plan about investment priority and implementation in CPSFDR were damaged less by natural disaster.

6. DISCUSSION

The result of assessment revealed some limitations and issues of CPSFDRs. Most representative problems are summarized like them. First, most mitigation measures of CPSFDRs aimed to structural measures more than non-structural measures such as building facilities. In fact, the plan quality score of structural measures (Average = 66.70) is higher than non-structural measures (Average = 33.93). Most non-structural measures are described only necessity or fragmentary measures, while structural measures are described with numerical analysis and detail blueprints. In addition, all non-structural measures were suggested to whole region level, so it is difficult to make detail measures for small level regions. However, there is some problems and limitation in structural measures also. The section of structural measures just listed necessary facility and installation plans in CPSFDRs, and it has very low discrimination with facility management plans such as river master plan. In addition, there is a trend that a municipality with lower financial independence has higher plan quality about non-structural measures according to result of t-test. A municipality with well financial resources should establish CPSFDR with well-planned measures because of importance of them. The policy is needed to encourage to include more plan or implement about non-structural measures. For effective non-structural measures, the connectivity between urban plan and CPSFDRS should be reinforced, and it is included also in some laws or policies.

Second, most municipalities don’t reflect regional characteristics to non-structural measures in their CPSFDRs. Most plans were established to refer to guideline of CPSFDR that given by Ministry of Public Safety and Security, and mitigation measures were established for types of natural disaster that are suggested in guideline mainly. For that reason, most plans have similar non-structural measures of each municipality, and some sentences and example pictures are even same in spite of different municipalities. There are regional characteristics about types of natural disaster, disaster scale, and environment, and the degree of climate change and urban space change are also different in each municipality. In addition, capabilities to cope with natural disaster are different locally. The plan is

necessary that can cover all of these regional characteristics. The detail guideline of CPSFDRs should include the detail contents to guide selection of mitigation measures through presentation of detail measures. Especially, non-structural measures need the guideline, because most consulting companies don't develop new measures and repeat similar contents in each plan.

Third, the connectivity between CPSFDR and other related plans is deficiency. CPSFDR is the comprehensive plan for disaster damage reduction, but it is necessary to have a connectivity for effective damage reduction. Connectivity is described in the section of present condition with explanation of related plans, and it is included as an indicator to decide investment priority. Besides, the contents about plan connectivity were required by the detail guideline. However, they are perfunctory, and they didn't describe detail. Maps that are marked planning area and facilities should be included in CPSFDR to compare the contents in various related plans, and to analyze the relationship between plans. Connectivity between plans can be maximized by this map, also duplication of plans can be prevented. As this study mentioned, the connectivity between CPSFDR and urban plan is important to encourage non-structural measures and to make effective measures. For that, detail methodology should be added in the detail guideline with examples.

Last, there is no evaluation and monitoring plan in plan implementation. Countermeasures against Natural Disasters Act regulated that have to renew every 5 years, so most plans mentioned it simply. Continuous evaluation and monitoring should be enforced before renewal, but detailed plans of them are not proposed in plans. It is important to improve the quality of CPSFDR consistently with feedback process. The detail guideline should include the contents about continuous evaluation and monitoring to establish detail plans for that. Especially. the example of evaluation categories should be proposed in the guideline with that contents.

7. CONCLUSION

In this study, qualities of 49 comprehensive plans for storm and flood damage reduction were assessed by 75 plan quality index. Content analysis was used to assess CPSFDRs, and it was quantified by 0-to-2 scale. Plan quality scores were converted to 100 scales to analyze easily. The average plan quality score is 50.41, and it means that the overall plan quality is very low. Haman (county) scored the highest score as 58.10, and Goesan (county) scored the lowest score as 41.56. Overall plan quality has negative relationship between disaster property damage from 2013 to 2014. There is a trend that municipalities which have higher overall plan quality were damaged by disaster lower than other municipalities. Most studies about CPSFDR use content analysis also, but they didn't used quantitative method. Therefore, they were difficult to compare the quality of plans and to represent visually in graph or map. However, this study attempts to assess the plans quantitatively with plan quality index and quantitative method,

and it helps to compare qualities easily and to use statistical analysis with other variables.

Plan qualities of each indicator were analyzed also, and some problems and limitations of CPSFDR were found. First, most mitigation measures of CPSFDRs aimed to structural measures more than non-structural. Second, most municipalities don't reflect regional characteristics in their CPSFDRs. Third, the connectivity between CPSFDR and other related plans is deficiency. Last, there is no evaluation and monitoring plan in plan implementation process. These problems should be modified and supplemented for better CPSFDRs.

There are some limitations in this study. First is the data limitation. As of March 2015, 95 CPSFDRs were approved (Joo et al., 2015), but only 49 plans were used in this study. Most CPSFDRs are not open to the public differ from urban master plans of each municipality because of the massive amount of plans. Most municipalities possess CPSFDRs as DVDs or books. In this study, CPSFDRs that is available in National Emergency Management Agency were used to assess because of that limitations. It is essential to expand the scope of study area for regional comparison, also it will be used to develop plan quality index because of plan diversity. In addition, more samples can help to analyze regional characteristics, because diversity of samples will rise when a number of sample increase. Second, the plan quality index was developed based on article about research of hazard mitigation plans in U.S. For that, it has limitation to assess absolute plan quality of CPSFDR in Korea. It is necessary to supplement using detail guidelines or various CPSFDRs in Korea. Third, detail analysis for related plans are shortage. In this study, the connectivity was assessed and analyzed in CPSFDRs only. However, it is necessary to analyze related section of other plans to assess the quality of connectivity. Last, disaster property damages from 2012 to 2014 were used for correlation analysis to consider establishment periods. CPSFDR set a goal after 10 years later, so it needs to use disaster damages after long period as 10 years to analyze effects of plan.

REFERENCE

Baer, W. C. (1997). General plan evaluation criteria: An approach to making better plans. *Journal of the American Planning Association*, 63(3), 329-344.

Berke, P. R. (1994). Evaluating environmental plan quality: the case of planning for sustainable development in New Zealand. *Journal of Environmental Planning and Management*, 37(2), 155-169.

Berke, P., Godschalk, D., Kaiser, E. and Rodriguez, D. (2006). *Urban land use planning*, University of Illinois Press.

Berke, P. R., & Conroy, M. M. (2000). Are we planning for sustainable development? An evaluation of 30 comprehensive plans. *Journal of the American planning association*, 66(1), 21-33.

Berke, P., Roenigk, D. J., Kaiser, E. J., & Burby, R. (1996). Enhancing plan quality: evaluating the role of state planning mandates for natural hazard mitigation. *Journal of environmental planning and management*, 39(1), 79-96.

Berke, P., Smith, G., & Lyles, W. (2012). Planning for resiliency: Evaluation of state hazard mitigation plans under the disaster mitigation act. *Natural Hazards Review*, 13(2), 139-149.

Brody, S. D. (2003). Are we learning to make better plans? A longitudinal analysis of plan quality associated with natural hazards. *Journal of Planning Education and Research*, 23(2), 191-201.

Evans-Cowley, J. S., & Gough, M. Z. (2008). Evaluating environmental protection in post-Hurricane Katrina plans in Mississippi. *Journal of Environmental Planning and Management*, 51(3), 399-419.

Godschalk, D. R. (2003). Urban hazard mitigation: creating resilient cities. *Natural hazards review*, 4(3), 136-143.

Godschalk, D. R., & Brower, D. J. (1985). Mitigation strategies and integrated emergency management. *Public Administration Review*, 64-71.

Horney, J. A., Naimi, A. I., Lyles, W., Simon, M., Salvesen, D., & Berke, P. (2012). Assessing the relationship between hazard mitigation plan quality and rural status in a cohort of 57 counties from 3 states in the southeastern US. *Challenges*, 3(2), 183-193.

Joo, J., Jung, D., & Kim, Y. (2015). Development of Operation · Management System of

Comprehensive Plan for Storm and Flood Damage Reduction. *Journal of Korean Society of Hazard mitigation*, 15(3), 131-139

Kaiser, E. J., Godschalk, D. R., & Chapin, F. S. (1995). *Urban land use planning*. University of Illinois Press.

Kang, J. E. (2012). An assessment of flood mitigation policies integrated in local comprehensive plans: The case of Florida in the United States. *Journal of Environmental Policy*, 11(4), 59-84.

Kang, J. E., Peacock, W. G., & Husein, R. (2010). An assessment of coastal zone hazard mitigation plans in Texas. *Journal of Disaster Research*, 5(5), 526-534.

Kang, J. E., Hyun, K., & Park, K. (2014). Assessment of Low Impact Development (LID) Integrated in Local Comprehensive Plans for Improving Urban Water Cycle. *Journal of the Korean Society of Civil Engineers*, 34(5), 1625-1638

Kim, J. E., Park, H. J., Lee, S. H., & Jung, J. C. (2015). Institutional Improvements on Korean Comprehensive Plans for the Reduction of Damage from Storm and Flood. *Korean Review of Crisis & Emergency Management,* 11(7), 35-49

Lyles, W., & Stevens, M. (2014). Plan Quality Evaluation 1994–2012 Growth and Contributions, Limitations, and New Directions. *Journal of Planning Education and Research*, 34(4), 433-450

Lyles, W., Berke, P., & Smith, G. (2014). A comparison of local hazard mitigation plan quality in six states, USA. *Landscape and Urban Planning*, 122, 89-99.

Mileti, D. (1999). *Disasters by Design: A Reassessment of Natural Hazards in the United States*. Washington, D.C.: Joseph Henry Press.

Mileti, D., & Peek-Gottschlich, L. (2001). Hazards and sustainable development in the United States. *Risk Management*, 61-70.

Ok, J. A., & Ryu, K. W. (2013) Linkage Policy between Comprehensive Disaster Management Plan and the Urban Plan in Gyeonggi-do. *Policy Research 2013-50*, 1-133.

Phillips, B. D., Neal, D. M., & Webb, G. (2011). *Introduction to emergency management*. CRC Press.

Schneider, R.O. (2002). Hazard Mitigation and Sustainable Community Development. *Disaster Prevention and Management*, 11(2), 141–147.

Srivastava, R., & Laurian, L. (2006). Natural hazard mitigation in local comprehensive plans: The case of flood, wildfire and drought planning in Arizona. *Disaster Prevention and*

Management: An International Journal, 15(3), 461-483.

Tang, Z. (2008). Evaluating local coastal zone land use planning capacities in California. *Ocean & Coastal Management*, 51(7), 544-555.

UNISDR. (2005). Hyogo framework for action 2005-2015: Building the Resilience of Nations and Communities to Disasters. *In Extract from the final report of the World Conference on Disaster Reduction (A/CONF. 206/6)*.

APPENDIX

- Plan quality index

Fact basis

Indicator		Element
Hazard analysis		Causes of disaster
		Hazard frequency
		Scale of disaster damage
		Analysis of disaster trend by climate change
		Characteristics of each disaster type
		Case analysis of each disaster
Vulnerability analysis	Vulnerable population	Definition of vulnerable population
		Present condition of vulnerable population
		Analysis of future vulnerable population
	Vulnerable facility	Definition of vulnerable facility
		Present condition of critical facility
		Present condition of cultural facility
		Present condition of hazardous material facility
	Vulnerable region	Definition of vulnerable region
		Present condition of vulnerable area of river disaster
		Present condition of vulnerable area of inundation
		Present condition of vulnerable area of mud flow disaster
		Present condition of vulnerable area of wind disaster
		Present condition of vulnerable area of other disaster (facility and ocean)
		Explanation about disaster risk districts
		Analysis of vulnerable region change by urban development
Capacity analysis	Manpower and organizations	Present condition of existing disaster management organizations
		Related organizations of disaster management
		Present condition of voluntary organizations
		People in charge about disaster management task
	Resources and supplies	Present condition of disaster related resources
		Present condition of relief goods

	Facility	Present condition and analysis of existing disaster mitigation facilities
		Present condition of shelters
		Present condition of existing EAP (Emergency Action Plan)
	Plan and education	Present condition of existing disaster related plans
		Connectivity between disaster related plans and CPSFDR
		Present condition of disaster related education or training

Mitigation measures

Indicator		**Element**
Direction establishment		Consideration of regional characteristics
		Consideration of future environment
		Consideration of connectivity with urban plan or disaster related plan
		Consideration of resilience or sustainability
Structural measures		Contents of dam construction or management
		Contents of levee construction or management
		Contents of river management
		Contents of rainwater storage facilities
		Contents of rainwater penetration facilities
		Contents of drainage pump facilities
		Contents of retarding reservoirs
		Contents of drainage lines
		Contents of slope stability measures
		Contents of elevation of a ground level
		Contents of structure reinforcement
Non-structural measures	Regulation	Contents of land use regulation
		Contents of building codes
		Contents of evacuation criteria
		Contents of natural environment conservation
	Incentive	Contents of tax benefits
		Contents of vulnerable population support
		Contents of storm and flood insurance expansion
		Contents of enhancement of volunteers and citizen participation

	Education and training	Contents of EAP establishment or related training
		Contents of education and training for citizen
		Contents of education and training for public officials
	Information	Contents of emergency communication system
		Contents of hazard maps
		Contents of forecasting and warning system
		Contents of risk signboards

Plan implementation

Indicator	Element
Investment priority and plan	Measures of investment priority decision
	Result of investment priority decision
	Consideration of connectivity in investment priority decision process
	Measures of financing to implement plan
Evaluation and improvement	Contents of plan evaluation and monitoring
	Plans for modification, renewal, and supplementation
	Measures to participate people in plan evaluation and renewal
Implementation and application	Contents of implementation plan by year
	Contents of expected effect of each mitigation measure
	Plans to implementation to connect with nearby municipalities
	Measures to use to establish related plans
	Measures to utilize plan for which organizations